CLAIMS

1. System (S, S') for non-contact measurement of a relative displacement or of a relative position of a first object with respect to a second object, comprising:
- a sensor module (1) comprising a transmitting plate (T) fixed to said first object and a receiving plate (R) connected to said second object, said first transmitting plates and said second receiving plate being arranged substantially facing each other and provided with transmitting and receiving electrodes respectively,
- means (22) of applying high-frequency excitation signals to said transmitting electrodes,
- means of taking high-frequency modulated measurement signals from said receiving electrodes, and
- means (2, 500) of processing said measurement signals thus taken in order to supply signals representing the relative displacement or the relative position of said first object with respect to said second object,

characterized in that the transmitting and receiving electrodes are arranged to constitute a first capacitance varying as a function of the distance separating the transmitting and receiving plates respectively and a second capacitance varying as a function of the relative misalignment of said plates, and in that the processing means are designed to perform, on the basis of the measurement signals taken, an analogue calculation (i) of a first signal representing the inverse of said first capacitance and (ii) of a second signal representing the ratio of the second capacitance to said first capacitance.

2. System (S, S') for non-contact measurement according to claim 1, characterized in that the transmitting electrodes comprise at least a first transmitting electrode (T1) with a first polarity, a second transmitting electrode (TA) with said first polarity and a transmitting electrode (TB) with a second polarity that is the inverse of said first polarity, the receiving electrodes comprising at least a first receiving electrode (R1) substantially facing said first transmitting electrode (T1) and a second receiving electrode (R(A-B)) substantially facing a part of said second transmitting electrode (TA) and a part of said transmitting electrode (TB) of inverse polarity.

3. System for measurement according to claim 2, characterized in that the transmitting electrodes comprise two first transmitting electrodes (T1, T2) with the first polarity exhibiting substantially the same first geometric shape, and in that the receiving electrodes comprise two first receiving electrodes (R1, R2) exhibiting said first geometric shape and arranged within the receiving plate in order to be respectively facing said first transmitting electrodes when said transmitting and receiving plates are in alignment.

4. System for measurement according to one of claims 2 or 3, characterized in that the second transmitting electrode (TA) and the transmitting electrode of inverse polarity (TB) exhibit the same second geometric shape and are arranged parallel and in close proximity to each other.

5. System for measurement according to claim 4, characterized in that the second receiving electrode (R(A-B)) is preferably arranged within the receiving plate such that the projection of said second receiving electrode on the transmitting plate is included within a perimeter including the contours of the second transmitting electrode (TA) and of the receiving electrode of inverse polarity (TB).

6. System for measurement according to one of claims 4 or 5, characterized in that the two first transmitting electrodes (T1, T2) and the second transmitting electrode (TA) are electrically connected and excited by a same high-frequency modulated excitation signal, and in that the two first receiving electrodes (R1, R2) are electrically connected.

7. System for measurement according to one of claims 4 to 6, characterized in that the processing means comprise means for performing the analogue calculation:

$$1/(C1+C2)$$

where C1 and C2 are the capacitances respectively constituted by the first transmitting electrodes (T1, T2) and the first receiving electrodes (R1, R2).

8. System for measurement according to one of claims 4 to 7, characterized in that the processing means comprise means of performing the analogue calculation:

$$CA-CB/(C1+C2)$$

where C1 and C2 are the capacitances respectively constituted by the first transmitting electrodes (T1, T2) and the first receiving electrodes (R1, R2) and where CA-CB represents the capacitance constituted by, on the one hand, the second transmitting electrode (TA) and the transmitting electrode of inverse polarity (TB) and, on the other hand, the second receiving electrode (R(A-B)).

9. System for measurement according to claims 7 and 8, characterized in that the processing means comprise a preamplifier stage (20) for pre-amplifying the measurement signals respectively taken from the second receiving electrode (R(A-B)) and from the two first, electrically connected, receiving electrodes (R1, R2), upstream of the analogue calculation means (21).

10. System for measurement according to claim 9, characterized in that the analogue calculation means are designed to process analogue offset information supplied by digital-to-analogue conversion means connected to digital control means.

11. System for measurement according to one of claims 9 or 10, characterized in that the analogue calculation means comprise means of demodulating the signals resulting from the analogue calculations.

12. System for measurement according to any one of the preceding claims, characterized in that the transmitting and receiving plates respectively comprise supports made of flexible material.

13. System for measurement according to claim 12, characterized in that the flexible material constituting the supports is polyamide.

14. System for measurement according to one of claims 12 or 13, characterized in that the flexible material constituting the supports is made from a flexible printed circuit.

15. System for measurement according to one of claims 12 to 14, in which at least said first and second objects comprise a mirror, characterized in that at least one of the supports made of flexible material is glued to said mirror.

16. System (S') for measurement according to any one of the preceding claims, characterized in that the processing means (500) comprise a first charge amplifier (501) whose input is connected to the third receiving electrode R(A-B) and to the output of a first modulator (511) connected as a multiplier, and a second charge amplifier (502) whose input is connected to the first and second receiving electrodes (R1, R2) and to the output of a second modulator (512) connected as a divider, the respective outputs of said first and second charge amplifiers (501, 502) being respectively connected as input to a first and to a second synchronous demodulator (515, 516) controlled by oscillator means, the respective outputs of said first and second synchronous demodulators (515, 516) being applied as input to a first and to a second integrator (517, 518) respectively, supplying a first analogue signal (Voz) representing the quantity $K\left[\frac{CA-CB}{C1+C2} \pm ka\right]$ and a second analogue signal (Voy) representing the quantity $k\left[\frac{1}{C1+C2}\right]$.

17. System (S') for measurement according to claim 16, characterized in that the processing means (500) further comprise a first and a second high-frequency amplifier (505, 504) respectively arranged, on the one hand, between the outputs of the first and second charge amplifiers (501, 502) and, on the other hand, between the inputs of the first and second synchronous demodulators (515, 516).

18. Application of the system for measurement according to one of the preceding claims, for measuring the relative position between two adjacent mirror segments.

19. Application according to claim 18, in which the transmitting and receiving plates respectively are fixed to facing lateral edges of two adjacent mirror segments, in close proximity to the active surfaces of said mirror segments.

20. Application according to claim 19, in which the non-contact system for measurement according to one of claims 1 to 11 is used for controlling the position (Tilt, Tip, piston and Global Radius of Curvature (GROC) of the mirror) of mirror segments.

21. Application according to one of claims 18 to 20, in the field of large-sized telescopes with segmented mirrors.

22. Method for non-contact measurement of a relative displacement or of a relative position of a first object with respect to a second object, used in a system according to one of the preceding claims, comprising:
- an application of high-frequency excitation signals to transmitting electrodes arranged on a transmitting plate fixed to said first object,
- a taking of high-frequency modulated measurement signals from receiving electrodes arranged on a receiving plate fixed to said second object, at least a part of said electrodes, transmitting and receiving respectively, being substantially facing each other when the transmitting and receiving plates respectively are substantially aligned,
- a processing of said measurement signals thus taken in such a way as to provide signals representing the relative displacement or the relative position of said first object with respect to said second object,
characterized in that this processing comprises an analogue calculation (i) of a first signal representing the inverse of a first capacitance and (ii) of a second signal representing the ratio of a second capacitance to said first capacitance,

said first capacitance being constituted by at least one of said transmitting electrodes and at least one of said receiving electrodes in such a way as to vary as a function of the distance separating the transmitting and receiving plates respectively, and said second capacitance being constituted by at least another of said transmitting electrodes and at least another of said receiving electrodes in such a way as to vary as a function of the relative misalignment of said plates.

23. Method for measurement according to claim 22, in which the transmitting electrodes comprise two first transmitting electrodes (T1, T2), a second transmitting electrode (TA) and a transmitting electrode (TB) with a polarity that is the inverse of that of said second transmitting electrode (TA), the receiving electrodes comprise two first receiving electrodes (R1, R2) and a second receiving electrode (R(A-B)) facing at least a part of said second transmitting electrode (TA) and at least a second part of said transmitting electrode (TB) of inverse polarity, said first transmitting electrodes and said second transmitting electrode being electrically connected and excited by the same high-frequency modulated excitation signal, and said first receiving electrodes being electrically connected in order to constitute (i) a capacitance C1+C2 corresponding to the putting in parallel of two capacitances (C1, C2) respectively constituted by each first transmitting electrode (T1, T2) and each corresponding first receiving electrode (R1, R2).

24. Method for measurement according to claim 23, characterized in that the analogue calculation comprises a calculation of the quantity:

$$1/(C1+C2)$$

where C1 and C2 are the capacitances respectively constituted by the first transmitting electrodes (T1, T2) and the first receiving electrodes (R1, R2).

25. Method for measurement according to claim 23, characterized in that the analogue calculation comprises a calculation of the quantity:

$$CA-CB/(C1+C2)$$

where C1 and C2 are the capacitances respectively constituted by the first transmitting electrodes (T1, T2) and the first receiving electrodes (R1, R2), and

where CA-CB represents the capacitance constituted by, on the one hand, the second transmitting electrode (TA) and the transmitting electrode of inverse polarity (TB) and, on the other hand, the second receiving electrode (R(A-B)).

26. Method according to one of claims 23 to 25, characterized in that it further comprises, prior to the analogue calculation, an ultra low noise pre-amplification of the measurement signals taken from the second receiving electrode (R(A-B)) and from the two first electrically connected receiving electrodes (R1, R2) respectively.